

What is claimed is:

1. A process for preparing a polar olefin copolymer comprising:

copolymerizing a non-polar olefin and a polar olefin

5 in the presence of a catalyst comprising

(A0) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (1):



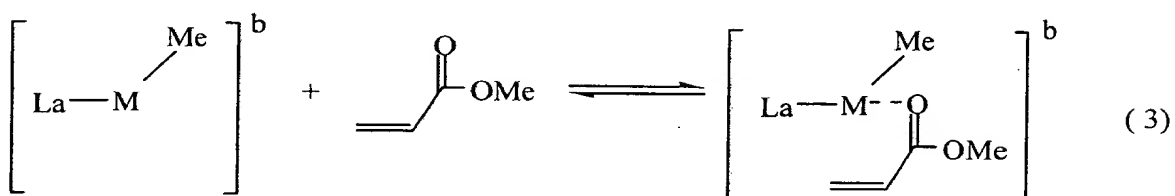
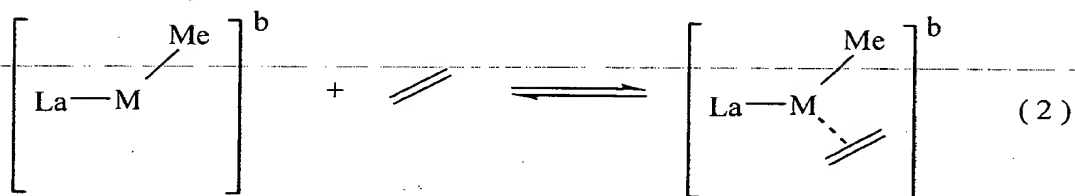
10 wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

m is an integer of 1 to 6,

n is a number satisfying a valence of M,

L is a ligand coordinated to M and each ligand L has
15 a feature that when the value obtained by subtracting the total sum of the whole energy, as determined by a density functional method, of the compounds on the left-hand member from the whole energy, as determined by a density functional method, of the compound on the right-hand
20 member in the following chemical formula (2) and the value obtained by the same subtraction in the following chemical formula (3) are defined as coordination energy E_1 of ethylene and coordination energy E_2 of methyl acrylate, respectively, the difference ΔE ($\Delta E = E_1 - E_2$) between the
25 coordination energy E_1 of ethylene and the coordination

energy E_2 of methyl acrylate is 50 kJ/mol or less,



5 wherein M is the same transition metal atom selected from Groups 3 to 11 of the periodic table as M in the formula (1), a is an integer of 1 to 3, b is an electric charge of the compound in the blankets [] and is 0 or 1, and Me is a methyl group,

10 and

 X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a
15 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, silicon-containing group, a germanium-containing group and a tin-containing group, and when n is 2 or greater, plural atoms or groups

indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring.

- 5 2. A process for preparing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising

(A0) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented
10 by the formula (1) as defined in claim 1, and

(B) at least one compound selected from the group consisting of

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

- 15 (B-3) a compound which reacts with a transition metal compound (A0) to form an ion pair.

3. The process for preparing a polar olefin copolymer as claimed in Claim 1 or 2, wherein the transition metal
20 compound represented by the general formula (1) is a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table.

4. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A1) a reaction product of

- 5 (C) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (c):



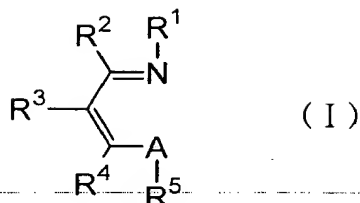
wherein M' is a transition metal atom selected from Groups
10 4, 5, 6 and 11 of the periodic table,

k is a number satisfying a valence of M', and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a
15 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups
20 indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-i) a compound represented by the following formula

(I):



wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R⁶, and

R¹ to R⁶ may be the same or different, they are each
 5 a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual-group, a silicon-
 10 containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring;
 and

(B) at least one compound selected from the group
 15 consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the reaction product (A1) to form an ion pair.

5. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A2) a reaction product of

- 5 (C) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (c):

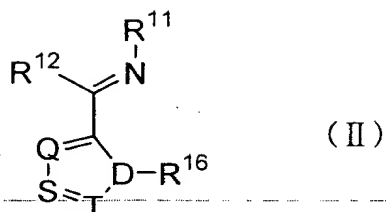


wherein M' is a transition metal atom selected from Groups
10 4, 5, 6 and 11 of the periodic table,

k is a number satisfying a valence of M', and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a
15 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups
20 indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-ii) a compound represented by the following formula (II):



wherein D is a nitrogen atom or a phosphorus atom,

Q is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹³,

5 S is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹⁴,

T is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹⁵,

R¹¹ to R¹⁶ may be the same or different, they are each
 10 a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual group, a silicon-
 15 containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring;
 and

(B) at least one compound selected from the group
 20 consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the reaction product (A2) to form an ion pair.

6. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A3) a reaction product of

(C') a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (c'):

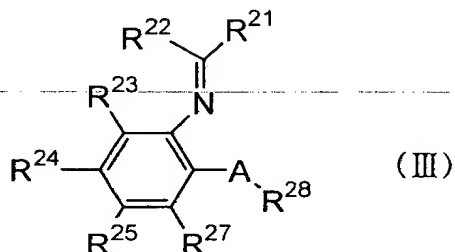


wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

k is a number satisfying a valence of M, and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-iii) a compound represented by the following formula (III):



- 5 wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R^{26} , and R^{21} to R^{28} may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a
- 10 nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to
- 15 each other to form a ring.

7. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- 20 (A3) a reaction product of

(C') a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (c'):

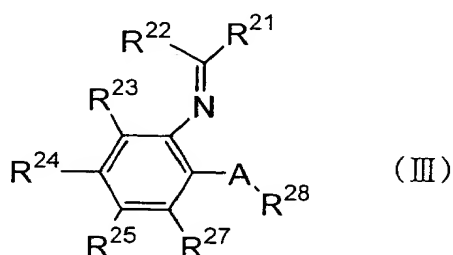


5 wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

k is a number satisfying a valence of M, and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-iii) a compound represented by the following
20 formula (III):



wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R^{26} , and

R^{21} to R^{28} may be the same or different, they are each
a hydrogen atom, a halogen atom, a hydrocarbon group, an
5 oxygen-containing group, a sulfur-containing group, a
nitrogen-containing group, a boron-containing group, an
aluminum-containing group, a phosphorus-containing group,
a heterocyclic compound residual group, a silicon-
containing group, a germanium-containing group or a tin-
10 containing group, two or more of them may be bonded to
each other to form a ring;
and

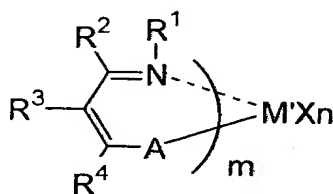
(B) at least one compound selected from the group
consisting of:

- 15 (B-1) an organometallic compound,
(B-2) an organoaluminum oxy-compound, and
(B-3) a compound which reacts with the transition
metal compound (A3) to form an ion pair.

20 8. The process for producing a polar olefin
copolymer as claimed in claim 6 or 7, wherein the compound
of a transition metal represented by the formula (c') is a
compound of a transition metal selected from Groups 4, 5,
6 and 11 of the periodic table.

9. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- (A4) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table, which is represented by the following formula (IV):



... (IV)

wherein M' is a transition metal atom selected from Groups 4, 5, 6 and 11 of the periodic table,

m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R⁶,

R¹ to R⁴ and R⁶ may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, a heterocyclic compound residual group, an oxygen-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a sulfur-containing group, a phosphorus-containing group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater,

one group of R^1 to R^4 and R^6 contained in one ligand and one group of R^1 to R^4 and R^6 contained in other ligands may be bonded, and R^1 s, R^2 s, R^3 s, R^4 s or R^6 s may be the same or different,

5 n is a number satisfying a valence of M' , and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a
10 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural
15 groups indicated by X may be bonded to each other to form a ring;
and

(B) at least one compound selected from the group consisting of:

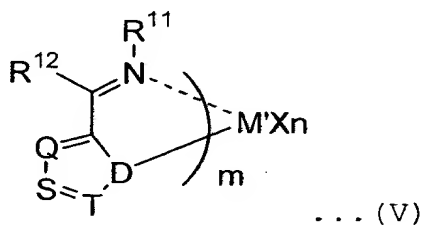
20 (B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the transition metal compound (A4) to form an ion pair.

10. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- (A5) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (V)



wherein M' is a transition metal atom selected from Groups 4, 5, 6 and 11 of the periodic table,

10 m is an integer of 1 to 6,

D is a nitrogen atom or a phosphorus atom,

Q is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹³,

15 S is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹⁴,

T is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R¹⁵,

R¹¹ to R¹⁵ may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group,

20

a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater, one

5 group of R^{11} to R^{15} contained in one ligand and one group of R^{11} to R^{15} contained in other ligands may be bonded, and $R^{11}s$, $R^{12}s$, $R^{13}s$, $R^{14}s$ or $R^{15}s$ may be the same or different,

n is a number satisfying a valence of M' , and

10 X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing
15 group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring;

20 and

(B) at least one compound selected from the group consisting of:

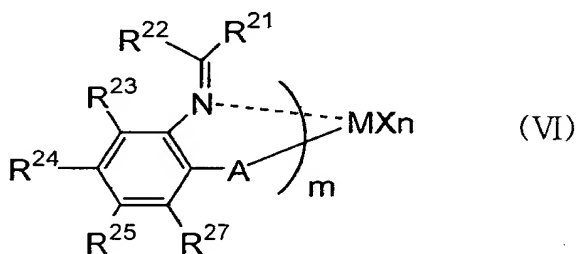
(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the transition metal compound (A5) to form an ion pair.

11. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A6) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (VI):



wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

15 m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R²⁶,

R²¹ to R²⁷ may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group,

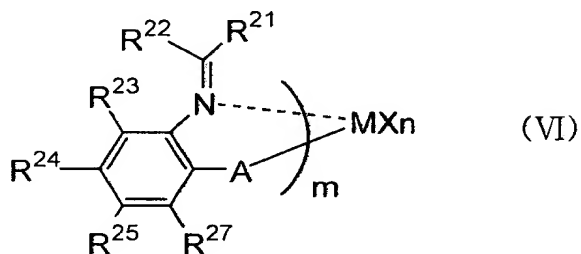
20

a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater, one
5 group of R^{21} to R^{27} contained in one ligand and one group of R^{21} to R^{27} contained in other ligands may be bonded, and $R^{21}s$, $R^{22}s$, $R^{23}s$, $R^{24}s$, $R^{25}s$, $R^{26}s$ or $R^{27}s$ may be the same or different,

n is a number satisfying a valence of M , and
10 X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a
15 heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form
20 a ring.

12. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A6) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (VI):



wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R^{26} ,

R^{21} to R^{27} may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater, one group of R^{21} to R^{27} contained in one ligand and one group of R^{21} to R^{27} contained in other ligands may be bonded, and

$R^{21}s$, $R^{22}s$, $R^{23}s$, $R^{24}s$, $R^{25}s$, $R^{26}s$ or $R^{27}s$ may be the same or different,

n is a number satisfying a valence of M , and

X is a hydrogen atom, a halogen atom, an oxygen atom,
5 a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing
10 group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring;

15 and

(B) at least one compound selected from the group consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

20 (B-3) a compound which reacts with the transition metal compound (A6) to form an ion pair.

13. The process for producing a polar olefin copolymer as claimed in claim 11 or 12, wherein the
25 compound of a transition metal represented by the formula

